Industrial engineers often use computers to improve products and services.

Their skills can be readily applied outside manufacturing as well. Some work in engineering and management services, utilities, and business services; others work for government agencies or as independent consultants.

Job Outlook
Employment of industrial engineers is expected to grow about as fast as the average for all occupations through 2008, reflecting industrial growth, more complex business operations, and greater use of automation in factories and offices. Because the main function of an industrial engineer is to make a higher quality product as efficiently as possible, their services should be in demand in the manufacturing sector as firms seek to reduce costs and increase productivity through scientific management. In addition to job growth, openings will result from the need to replace industrial engineers who transfer to other occupations or leave the labor force.

Earnings
Median annual earnings of industrial engineers were $52,610 in 1998. The middle 50 percent earned between $42,690 and $73,870. The lowest 10 percent earned less than $35,250 and the highest 10 percent earned more than $87,010. Median annual earnings in the manufacturing industries employing the largest numbers of industrial engineers in 1997 were:

Motor vehicles and equipment	$58,900
Electronic components and accessories	48,800
Aircraft and parts	44,100

According to a 1999 salary survey by the National Association of Colleges and Employers, bachelor's degree candidates in industrial engineering received starting offers averaging about $43,100 a year; master's degree candidates, $49,900.

(See introduction to the section on engineers for information on working conditions, training requirements, and sources of additional information.)

Materials Engineers

(O*NET 22105A, 22105B, 22105C, and 22105D)

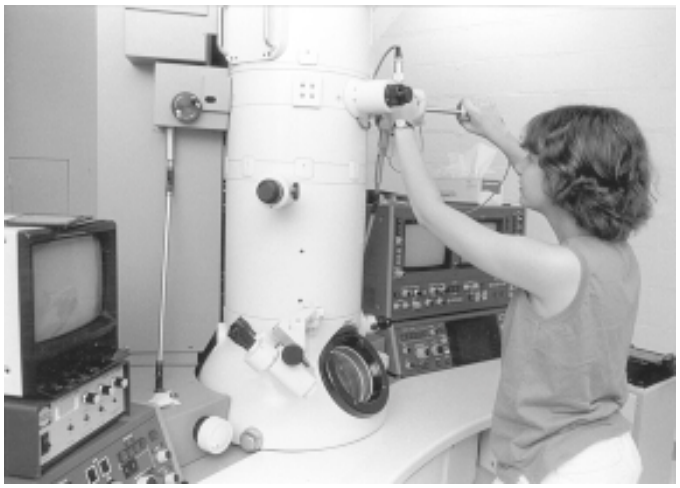
Nature of the Work
Materials engineers manipulate the atomic and molecular structure of substances to create products such as computer chips and television screens to golf clubs and snow skis. They work with metals, ceramics, plastics, semiconductors, and combinations of materials called composites to create new materials that meet certain mechanical, electrical, and chemical requirements. They also test and evaluate existing materials for new applications. Materials engineers specializing in metals can be considered *metallurgical engineers*, while those specializing in ceramics can be considered *ceramic engineers*.

Most metallurgical engineers work in one of the three main branches of metallurgy—extractive or chemical, physical, and mechanical or process. Extractive metallurgists are concerned with removing metals from ores and refining and alloying them to obtain useful metal. Physical metallurgists study the nature, structure, and physical properties of metals and their alloys, and methods of processing them into final products. Mechanical metallurgists develop and improve metalworking processes such as casting, forging, rolling, and drawing.

Ceramic engineers develop new ceramic materials and methods for making ceramic materials into useful products. Ceramics include all nonmetallic, inorganic materials that generally require high temperatures in their processing. Ceramic engineers work on products as diverse as glassware, automobile and aircraft engine components, fiber-optic communication lines, tile, and electric insulators.

Employment
Materials engineers held about 20,000 jobs in 1998. Because materials are building blocks for other goods, materials engineers are widely distributed among manufacturing industries. In fact, over half of materials engineers worked in metal-producing and processing; electronic and other electrical equipment; transportation equipment; industrial machinery and equipment; and stone, clay, and glass products manufacturing. They also worked in services industries such as engineering and management, business, and health services. Most remaining materials engineers worked for Federal and State governments.

Job Outlook
Employment of materials engineers is expected to grow more slowly than the average for all occupations through 2008. Many of the manufacturing industries in which materials engineers are concentrated—such as primary metals; industrial machinery and equipment; and stone, clay, and glass products—are expected to experience declines in employment. As firms outsource their materials engineering needs, however, employment growth is expected in many services industries including research and testing, personnel



Materials engineers analyze the physical and chemical characteristics of substances.

supply, health, and engineering and architectural services. In addition to growth, job openings will result from the need to replace materials engineers who transfer to other occupations or leave the labor force.

Earnings
Median annual earnings of materials engineers were $57,970 in 1998. The middle 50 percent earned between $43,890 and $77,730. The lowest 10 percent earned less than $34,890 and the highest 10 percent earned more than $89,600. In the Federal Government, materials engineers in supervisory, nonsupervisory, and management positions averaged $68,000 a year in early 1999.

According to a 1999 salary survey by the National Association of Colleges and Employers, bachelor's degree candidates in materials engineering received starting offers averaging about $43,400 a year.

(See introduction to the section on engineers for information on working conditions, training requirements, and sources of additional information.)

Mechanical Engineers

(O*NET 22135)

Nature of the Work
Mechanical engineers research, develop, design, manufacture and test tools, engines, machines, and other mechanical devices. They work on power-producing machines such as electricity-producing generators, internal combustion engines, steam and gas turbines, and jet and rocket engines. They also develop power-using machines such as refrigeration and air-conditioning equipment, robots used in manufacturing, machine tools, materials handling systems, and industrial production equipment. Mechanical engineers also design tools needed by other engineers for their work.

Mechanical engineers work in many industries and their work varies by industry and function. Some specialties include applied mechanics; computer-aided design and manufacturing; energy systems; pressure vessels and piping; and heating, refrigeration, and air-conditioning systems. Mechanical engineering is the broadest engineering discipline, extending across many interdependent specialties. Mechanical engineers may work in production operations, maintenance, or technical sales; many are administrators or managers.

Mechanical engineers increasingly use computers to perform modeling and simulation.

Employment
Mechanical engineers held about 220,000 jobs in 1998. Almost 3 out of 5 jobs were in manufacturing—mostly in machinery, transportation equipment, electrical equipment, instruments, and fabricated metal products industries. Engineering and management services, business services, and the Federal Government provided most of the remaining jobs.

Job Outlook
Employment of mechanical engineers is projected to grow about as fast as the average for all occupations though 2008. Although overall manufacturing employment is expected to decline, employment of mechanical engineers in manufacturing should increase as the demand for improved machinery and machine tools grows and industrial machinery and processes become increasingly complex. Employment of mechanical engineers in business and engineering services firms is expected to grow faster than average as other industries in the economy increasingly contract out to these firms to solve engineering problems. In addition to job openings from growth, many openings should result from the need to replace workers who transfer to other occupations or leave the labor force.

Earnings
Median annual earnings of mechanical engineers were $53,290 in 1998. The middle 50 percent earned between $42,680 and $74,220. The lowest 10 percent earned less than $35,290 and the highest 10 percent earned more than $87,000. Median annual earnings in the industries employing the largest numbers of mechanical engineers in 1997 were:

Federal government	$66,800
Engineering and architectural services	55,800
Electronic components and accessories	52,900
Aircraft and parts	51,800
Motor vehicles and equipment	48,500

According to a 1999 salary survey by the National Association of Colleges and Employers, bachelor's degree candidates in mechanical engineering received starting offers averaging about $43,300 a year; master's degree candidates, $51,900; and Ph.D. candidates, $64,300.

(See introduction to the section on engineers for information on working conditions, training requirements, and sources of additional information.)

Mining Engineers, Including Mine Safety Engineers

(O*NET 22108)

Nature of the Work
Mining engineers find, extract, and prepare coal, metals, and minerals for use by manufacturing industries and utilities. They design open pit and underground mines, supervise the construction of mine shafts and tunnels in underground operations, and devise methods for transporting minerals to processing plants. Mining engineers are responsible for the safe, economical, and environmentally sound operation of mines. Some mining engineers work with geologists and metallurgical engineers to locate and appraise new ore deposits. Others develop new mining equipment or direct mineral processing operations to separate minerals from the dirt, rock, and other materials with which they are mixed. Mining engineers frequently specialize in the mining of one mineral or metal, such as coal or gold. With increased emphasis on protecting the environment, many mining engineers work to solve problems related to land reclamation and water and air pollution.